Title:

Direct observations of atmospheric boundary layer response to SST variations associated with tropical instability waves over the eastern equatorial Pacific

Authors:

Hiroshi Hashizume, Shang-Ping Xie, Masatomo Fujiwara, Masato Shiotani, Tomowo Watanabe, Youichi Tanimoto, W. Timothy Liu, and Kensuke Takeuchi

Abstract:

Tropical instability waves (TIWs), with a typical wavelength of 1000 km and period of 30 days, cause the equatorial front to meander and result in sea surface temperature (SST) variations on the order of 1-2C. Vertical soundings of temperature, humidity and wind velocity were obtained on board of a Japanese research vessel, which sailed through three fully developed SST waves from 140W to 110W along 2N during September 21-28, 1999. A strong temperature inversion is observed throughout the cruise along 2N, capping the planetary boundary layer (PBL) that is 1-1.5 km deep. Temperature response to TIW-induced SST changes penetrates the whole depth of the PBL. In response to a SST increase, air temperature rises in the lowest km and shows a strong cooling at the mean inversion height. As a result, this temperature dipole is associated with little TIW signal in the observed sea level pressure (SLP).

The cruise-mean vertical profiles show a speed maximum at 400-500 m for both zonal and meridional velocities. SST-based composite profiles of zonal wind velocity show weakened (intensified) vertical shear within the PBL that is consistent with enhanced (reduced) vertical mixing, causing surface wind to accelerate (decelerate) over warm (cold) SSTs. Taken together, our temperature and wind soundings indicate the dominance of the vertical mixing over the SLP-driving mechanism. Based on our measurements, a physical interpretation of the widely used PBL model proposed by Lindzen and Nigam (1987, J. Atmos. Sci.,p.2418-2436) is presented.